

What is claimed is:

1. A clamp for securing a work piece during a manufacturing operation, comprising:
a support arranged to at least partially surround a circumference defining a work area
on the work piece, the support having a first end movable relative to a surface of
5 the work piece; and

at least one friction reducing element attached to the first end and disposed between
the support and the work piece, the friction reducing element adapted to at least
partially surround the circumference and to apply a clamping pressure to the
surface when the clamp is engaged with the work piece and moved across the
10 work piece.

2. The clamp of Claim 1, wherein the support is adapted to substantially surround the
circumference.

15 3. The clamp of Claim 1, wherein the work area includes a friction stir welding area.

4. The clamp of Claim 1, wherein the circumference surrounds and is larger than a
diameter of a friction stir welding tool.

20 5. The clamp of Claim 1, wherein the support includes a cylinder.

6. The clamp of Claim 1, wherein the friction reducing element includes a lubricant.

25 7. The clamp of Claim 1, wherein the friction reducing element includes a low friction
material.

8. The clamp of Claim 7, wherein the low friction material includes TEFLON®.

30 9. The clamp of Claim 1, wherein the friction reducing element includes a self-
lubricating material.

10. The clamp of Claim 9, wherein the self lubricating material includes one of high-
carbon cast iron, carbon graphite impregnates, molydisulfide impregnates, and metal polymer
hybrids.

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11. The clamp of Claim 1, wherein the friction reducing element includes a plurality of ball bearings.
12. The clamp of Claim 11, wherein the plurality of ball bearings are at least partially held against the surface by fluid pressure.
13. The clamp of Claim 11, wherein the plurality of ball bearings are at least partially held against the surface by gas pressure.
- 10 14. The clamp of Claim 1, wherein the friction reducing element includes a plurality of roller bearings.
- 15 15. The clamp of Claim 14, wherein the roller bearings are held in pivoting holders.
16. The clamp of Claim 1, wherein the friction reducing element includes a race of bearings.
17. The clamp of Claim 1, wherein the friction reducing element includes a plurality of pivoting and rolling castors.
- 20 18. The clamp of Claim 1, wherein the friction reducing element includes a pressurized gas adapted to apply pressure to the surface.
19. The clamp of Claim 1, wherein the friction reducing element includes a pressurized fluid arranged to apply pressure to the surface
- 25 20. The clamp of Claim 1, wherein the support includes a mechanism to move the first end towards and away from the surface.
- 30 21. The clamp of Claim 20, wherein the mechanism includes at least one of a spring, a cam, a threaded adjusting link, a pneumatic actuator, a solenoid, an electromagnetic actuator, and a hydraulic actuator.
- 35 22. The clamp of Claim 20, wherein the mechanism includes a feedback system to maintain a specified pressure against the surface.



23. An apparatus for performing a manufacturing operation on a work piece, comprising:
- a manufacturing tool;
- a support adapted to at least partially surround the manufacturing tool, the support having a first end positioned to move relative to the manufacturing tool; and
- a friction reducing element attached to the first end, the friction reducing element adapted to at least partially surround the manufacturing tool and to apply a clamping pressure to the surface around the manufacturing tool.
- 10 24. The clamp of Claim 23, wherein the manufacturing tool includes a welding tool.
25. The clamp of Claim 24, wherein the welding tool includes a friction stir welding tool.
- 15 26. The clamp of Claim 23, wherein the support is adapted to substantially surrounding the manufacturing tool.
- 20 27. The clamp of Claim 23, wherein the support is adapted to co-annularly surround the manufacturing tool.
28. The clamp of Claim 23, wherein the support includes a cylinder substantially surrounding the friction stir welding tool.
- 25 29. The clamp of Claim 23, wherein the friction reducing element includes TEFLON®
- 30 30. The clamp of Claim 23, wherein the friction reducing element includes a self lubricating material.
- 30 31. The clamp of Claim 30, wherein the self lubricating material includes one of high-carbon cast iron, carbon graphite impregnates, molydisulfide impregnates and metal polymer hybrids.
- 35 32. The clamp of Claim 23, wherein the friction reducing element includes a plurality of ball bearings.



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33. The clamp of Claim 32, wherein the plurality of ball bearings are at least partially held against the surface by gas pressure.
- 5 34. The clamp of Claim 23 wherein the friction reducing element includes a plurality of roller bearings.
- 10 35. The clamp of Claim 34 wherein the roller bearings are held in pivoting holders.
- 10 36. The clamp of Claim 23, wherein the friction reducing element includes a race of bearings.
- 15 37. The clamp of Claim 23, wherein the friction reducing element includes a plurality of pivoting and rolling casters.
- 15 38. The clamp of Claim 23, wherein the friction reducing element includes a pressurized gas arranged to apply pressure to the surface.
- 20 39. The clamp of Claim 23, wherein the friction reducing element includes a pressurized fluid arranged to apply pressure to the surface
- 20 40. The clamp of Claim 23, wherein the support includes a mechanism to move the first end towards and away from the surface.
- 25 41. The clamp of Claim 40, wherein the mechanism includes at least one of a spring, a cam, a threaded adjusting link, a pneumatic actuator, a solenoid, an electromagnetic actuator, and a hydraulic actuator.
- 30 42. The clamp of Claim 40, wherein the mechanism includes a feedback system to maintain a specified pressure against the surface.
- 35 43. A clamp for securing a work piece during a manufacturing operation, comprising:
 a plurality of supports arranged to at least partially surround a manufacturing tool,
 each of the plurality of supports having a first end positionable relative to a
 surface of the work piece independent of the manufacturing tool and at least
 partially independent of the other supports; and



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a plurality of friction reducing elements, each friction reducing element attached to the first end of each of the plurality of supports, the friction reducing elements arranged to at least partially surround a working end of the manufacturing tool and to apply a movable clamping pressure to the surface around the manufacturing tool.

44. The clamp of Claim 43, wherein the manufacturing tool includes a welding tool.

45. The clamp of Claim 44, wherein the welding tool includes a friction stir welding tool.

46. The clamp of Claim 43, wherein the plurality of supports are adapted to substantially surrounding the manufacturing tool.

15 47. The clamp of Claim 43, wherein the plurality of supports are adapted to coannularly surround the manufacturing tool.

48. The clamp of Claim 43, wherein the each of the plurality of supports includes a holder arranged to hold a friction reducing element.

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49. A method for clamping during a manufacturing operation on a work piece, comprising:

applying a clamping force against the work piece, the clamping force being distributed over a clamping area that at least partially surrounds a work area on the work piece;

operatively engaging the work area with a manufacturing tool;

moving the work area by moving the manufacturing tool with the manufacturing tool operatively engaging the work area; and

30 moving the clamping area simultaneously with moving the work area, by moving the clamping area upon which the clamping force is applied along with moving the manufacturing tool.

50. The method of Claim 49, wherein manufacturing tool includes a welding tool.



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51. The method of Claim 50, wherein the welding tool includes a friction stir welding tool.
52. The method of Claim 49, wherein the clamping area substantially surrounding the manufacturing tool.
53. The method of Claim 49, wherein the clamping area coannularly surrounds the manufacturing tool.
- 10 54. The method of Claim 49, wherein applying a clamping force includes clamping the work piece before operatively engaging the work area with the manufacturing tool.
55. The method of Claim 49, further comprising conforming the clamping area to match a surface contour of the work piece.
- 15 56. A method for clamping during friction stir welding, comprising:
clamping a work piece co-annularly around the circumference of a working end of
friction stir welding tool; and
moving the clamping with the friction stir welding tool during friction stir welding.
57. The method of Claim 56, wherein clamping a work piece coannularly includes
clamping the work piece before engaging the work piece with the friction stir welding tool.
- 20 58. The method of Claim 56, further comprising:
conforming the clamping to match a surface contour of the work piece.
59. A device for clamping during a manufacturing operation, the apparatus comprising:
means for applying clamping pressure to a work piece around at least a portion of a
working end of a manufacturing tool working on the work piece; and
means for reducing friction between the means for applying clamping pressure and
the work piece.
- 25 60. The apparatus of Claim 59, wherein the manufacturing tool includes a welding tool.
61. The apparatus of Claim 60, wherein the welding tool includes a friction stir welding tool.



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62. The apparatus of Claim 59, wherein the means for applying clamping pressure include means for applying clamping pressure to a work piece at least partially surrounding a working end of a manufacturing tool working on the work piece.

63. The apparatus of Claim 59, wherein the means for applying clamping pressure include means for applying clamping pressure to a work piece co-annularly surrounding a working end of a manufacturing tool working on the work piece.

64. The apparatus of Claim 59, further comprising means for conforming the clamping pressure to a surface contour of work piece.

65. The apparatus of Claim 59, wherein the means for reducing friction include rolling means.

64. The apparatus of Claim 59, wherein the means for reducing friction includes pivoting means.

65. The apparatus of Claim 59, wherein the means for reducing friction include pressurized gas means.

66. The apparatus of Claim 59, wherein the means for reducing friction include pressurized fluid means.

67. The apparatus of Claim 59, wherein the means for reducing friction include lubricating means.

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